

ABSTRACT

A NEUTRON ACTIVATION GAMMA RAY SPECTROMETER FOR PLANETARY SURFACE ANALYSIS

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There are a number of planned and contemplated NASA, ESA, and Russian solar system lander missions that will characterize planets and small bodies over the next ten years. These include missions to the Moon, Mars, Venus, asteroids and comets. Except for gamma-ray spectrometers, the existing suite of "demonstrated" instruments can only characterize the first fraction of a millimeter of the surface for elemental composition unless drilling or excavating techniques are used. Cosmic-ray induced activation analysis by gamma-ray counting can determine the composition of significant volumes, but only with tens of hours counting time for high quality measurements.

A pulsed DT neutron generator probe system, similar to that used in commercial well logging, offers the possibility of performing accurate elemental analyses to depths of tens of centimeters in a few seconds with the probe on the body's surface. Through time-phased measurements of the gamma-ray spectrum synchronized with the neutron pulses, concentrations of hydrogen, carbon and key mineral forming elements can be determined even with a low-resolution spectrometer. If a high-resolution spectrometer is used, the number of elements measured and the sensitivity for measurement is increased. Of course the probe system could also be implanted under the surface to provide analysis at any desired depth.

An inexpensive neutron probe system based on minor modifications of the Schlumberger well-logging system has been proposed for the Discovery/Venera/SAGI Mission to Venus. The Schlumberger logging system would be physically unchanged to make packaging for the Venus surface environment practical. However, because the logging systems are mechanically and electrically designed for harsh deep-well conditions, no significant re-engineering of the generator and spectrometer systems is anticipated. The complete Neutron Activated Gamma-Ray Spectrometer (NAGS) experiment would have a mass of about 27 kg including extensive thermal packaging to insure a two-hour survival on the surface. The power requirement would be up to about 30 W, depending on the desired neutron output. This mass and power is well within the capability of the Vega lander to deliver and operate. For a less severe planetary environment, the neutron probe system could be redesigned to reduce the mass and power requirement by, perhaps, an order of magnitude.

A cooperative program between the Jet Propulsion Laboratory and Schlumberger-Doll Research is seeking to experimentally identify any problems with performing surface analyses with a neutron probe system. Initial tests are focusing on development of spectral reference standards that could be used in analysis of the Venusian surface. The results show that good analyses can be expected for a probe based on a pulsed generator in combination with a GSO scintillator spectrometer.